WATER MANAGEMENT BRANCH
ENVIRONMENT AND RESOURCE DIVISION
MINISTRY OF ENVIRONMENT, LANDS AND PARKS

AMBIENT WATER QUALITY OBJECTIVES FOR KEREMEOS CREEK WATERSHED

OVERVIEW REPORT

Prepared pursuant to Section 2(e) of the
Environment Management Act, 1981

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SUMMARY

This document is one in a series that presents ambient water quality objectives for British Columbia. It has two parts: this overview, which is available as a separate document, and the full report. This overview provides general information about water quality in the Keremeos Creek watershed. It is intended for both technical readers and for readers who may not be familiar with the process of setting water quality objectives. It includes tables listing water quality objectives and recommended monitoring. The main report presents the details of the water quality assessment for these waterbodies and forms the basis of the recommendations and objectives presented in this overview. Water quality objectives are recommended to protect aquatic life, wildlife, irrigation water supplies, livestock watering and drinking water supplies in Keremeos Creek, South Keremeos Creek, Cedar Creek and Olalla Creek.

There are a variety of human activities in the watershed which could degrade water quality. Increases in chloride in upper portions of the creek were caused by a gravel pit operation. Activities near Apex Mountain Resort were found to increase nutrients and sediments in upper portions of Keremeos Creek. Agricultural activities in the lower section of Keremeos Creek were found to increase nutrients and fecal coliform bacteria in the creek. More specific studies would be required to determine the impact of timber harvest on water quality. As the data used in this report is limited, additional sampling would be required to more fully document the nature of these effects and to determine attainment of the water quality objectives specified for the protection of the most sensitive water use.

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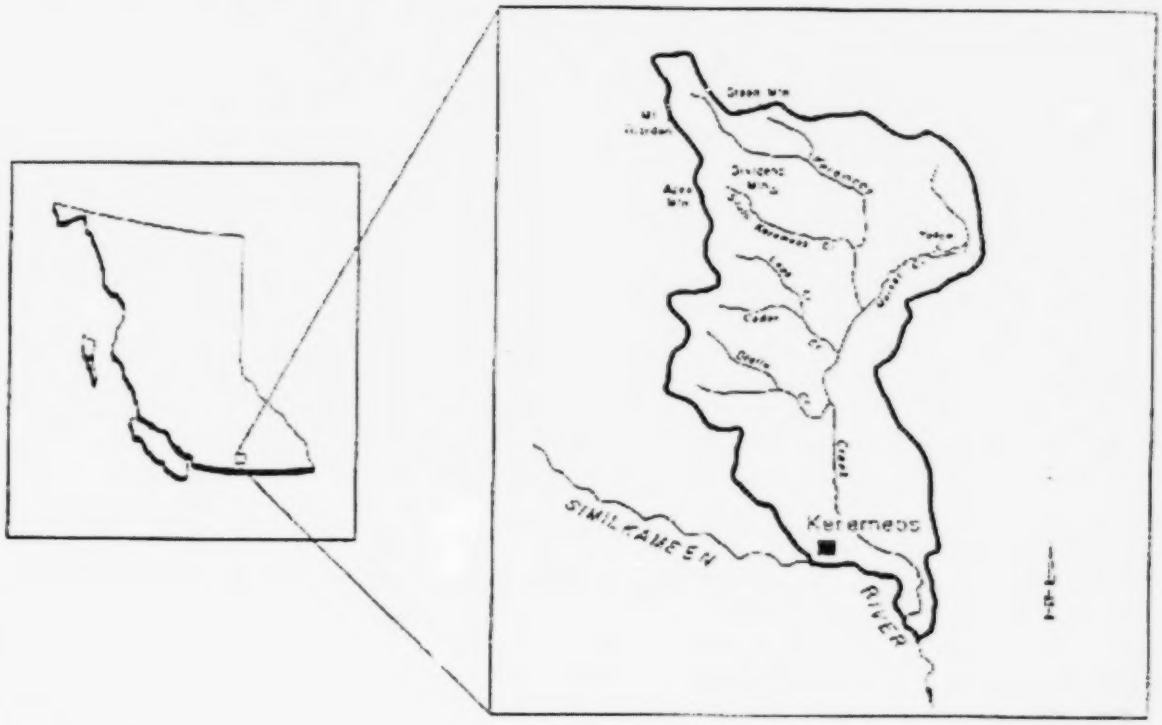
Figure 1. Keremeos Creek Watershed Location Map



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PREFACE

Purpose of Water Quality Objectives

Water quality objectives are prepared for specific bodies of fresh, estuarine and coastal marine surface waters of British Columbia as part of the Ministry of Environment, Lands and Parks' mandate to manage water quality. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity now or in the near future.

How Objectives Are Determined

Water quality objectives are based the BC approved and working criteria as well as national water quality guidelines. Water quality criteria and guidelines are safe limits of the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment which protect water use. Objectives are established in British Columbia for waterbodies on a site-specific basis. They are derived from the criteria by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. A designated water use is one that is protected in a given location and is one of the following:

- raw drinking water, public water supply, and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial water supplies.

Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical or biological characteristics affecting that waterbody.

How Objectives Are Used

Water quality objectives routinely provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives guide the evaluation of water quality, the issuing of permits, licences and orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular waterbody can be checked, and help to determine whether basin-wide water quality studies should be initiated.

Water quality objectives are also a standard for assessing the Ministry's performance in protecting water uses. While water quality objectives have no legal standing and are not directly enforced, these objectives become legally enforceable when included as a requirement of a permit, licence, order, or regulation, such as the Forest Practices Code Act, Water Act regulations or Waste Management Act regulations.

Objectives and Monitoring

Water quality objectives are established to protect all uses which may take place in a waterbody. Monitoring (sometimes called sampling) is undertaken to determine if all the designated water uses are being protected. The monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. It is assumed that if all designated water uses are protected at the critical time, then they also will be protected at other times when the threat is less.

The monitoring usually takes place during a five week period, which allows the specialists to measure the worst, as well as the average condition in the water.

For some waterbodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses, and the way the objectives are expressed (*i.e.*, mean value, maximum value).

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INTRODUCTION

This report assesses water quality of Keremeos Creek and its main tributaries: South Keremeos Creek, Cedar Creek and Olalla Creek (Figure 1). Although Keremeos Creek has been sampled historically near its confluence with the Similkameen River, much of the data presented in this report was gathered between November 1994 and July of 1997. Keremeos Creek and its tributaries are licenced for domestic and irrigation water supply. These creeks also provide fish rearing habitat and contain resident

populations of trout and a variety of other fish species, but census information and access are limited. A ski resort in the headwaters of Keremeos Creek, as well as agriculture, forestry and road maintenance operations, all influence the water quality of these creeks to varying degrees.

This document summarizes the BC Environment water quality data available for the watershed up to July 1997 and proposes water quality objectives for a number of parameters that may be affected by human activities noted above. These objectives are proposed to protect all water uses in Keremeos, South Keremeos, Cedar and Olalla creeks. FRBC funded monitoring since 1997 may be used to determine water quality objectives attainment and will be reported at a later date.

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HYDROLOGY

The flows in Keremeos Creek are monitored but not regulated. In upper and lower Keremeos Creek, high flows occur during the spring runoff, with flows decreasing so that the lowest flows are experienced during the summer months. Keremeos Creek has a drainage area of 250 km^2 at the mouth of the creek, Olalla Creek has a drainage area of 27 km^2, while South Keremeos Creek has a drainage area of 7 km^2 and Cedar Creek of 15 km^2. Mean seven-day low flows in Keremeos Creek were recorded at Olalla in the range of 0.212 to 0.216 m^3/s between July and September. An annual average freshet flow of 2.5 m^3/s is observed during May and June in Keremeos Creek at Olalla.

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WATER USE

As of 1997, consumptive water uses include domestic withdrawals totalling: 668 m^3/d on Keremeos Creek, 12m^3/d on Cedar Creek, and 150 m^3/d on Olalla Creek. Keremeos Creek drainage above the Gunbarrel intake (Apex Water Utility), and Olalla Creek above the Olalla intake (not in use), are Community Watersheds under the Forest Practices Code at the time this report was prepared. Irrigation use includes: 1724 dam^3/a in Keremeos Creek, 272 dam^3/a on Cedar Creek and 193dam^3/a on Olalla Creek.

Although the fishery value of Keremeos Creek is low due to limited access, it is rated highly as a rainbow trout producer for the Similkameen River. Similarly, while the fishery is considered low in both Cedar and Olalla creeks, these systems may be important rearing habitat for fish in Keremeos Creek and the Similkameen River. Rainbow and eastern brook trout, peamouth chub, carp, largescale suckers, redside shiners, squawfish and chiselmouth are known to reside in Keremeos Creek. Rainbow trout have been observed in Keremeos Creek near the Apex Resort (D. Shanner, pers. comm. 2000). Yellow perch are reported to be in Ford Lake (near Keremeos Creeks first crossing of Green Mountain Road) and may be in Keremeos Creek. In South Keremeos Creek, rainbow trout and eastern brook trout are known to exist in the creek below Green Mountain Road as the gradient and a culvert under Green Mountain Road present a barrier to fish migration. While the fishery is considered of low value in South Keremeos

Creek, it may serve as important rearing habitat for fish residing in waters downstream. Cedar and Olalla creeks both are known to contain eastern brook and rainbow trout.

The designated water uses for Keremeos Creek and Cedar Creek are aquatic life, wildlife, irrigation, livestock watering and drinking water supplies. The designated water uses for South Keremeos Creek are aquatic life, wildlife and livestock watering. The designated water uses for Olalla Creek are aquatic life, wildlife, irrigation, livestock watering and drinking water supplies.

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WASTE WATER DISCHARGES

There are few permitted refuse sites or wastewater discharges present in the Keremeos Creek watershed. No direct discharge of wastewater to Keremeos Creek has been permitted. The largest discharge under permit (BC Environment) in the Keremeos Creek watershed is from Apex Mountain Resort. This discharge of secondary-treated effluent occurs to infiltration ponds approximately 220 m east of upper Keremeos Creek. Upper Keremeos Creek water quality monitoring conducted during this study (November 1994-July 1997) near Apex Mountain Resort has shown slight increases in nitrogen and phosphorus concentrations in Keremeos Creek near this discharge. Additional creek and ground water sampling is needed to definitively determine the source of these nutrients and to ascertain what impact the sewage discharge may have on the creek.

Permitted waste discharges to ground within portions of the lower Keremeos Creek watershed are from a mobile home park septic system near Keremeos, and a small-volume discharge from a fruit packing plant in Cawston to a ground disposal system. There is also a permitted refuse site located near Keremeos. Given the small size and distance of these discharges from Keremeos Creek, it is unlikely that these sites have a measurable impact on Keremeos Creek.

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WATER QUALITY ASSESSMENT

Keremeos Creek

Although chloride enters Keremeos Creek near its headwaters from a gravel pit operation, no water use is compromised to date. Sediments enter upper Keremeos Creek from road run off, a gravel pit operation, and the ski runs and parking lot at the Apex Resort area. Although non-filterable residue (suspended sediment) levels in Keremeos Creek have decreased since erosion control measures were implemented by Apex Mountain Resort in 1995, further monitoring is required to ensure the works continue to be effective. Approximately 1900 head of cattle, 400 with creek access, in the lower Keremeos Creek area in the winter of 1994/1995, caused elevated fecal coliform bacteria counts and increased ammonia nitrogen concentrations. Due to the elevated fecal coliform bacteria levels, lower Keremeos Creek should not be used for drinking water without at least disinfection and partial treatment. The portion of Keremeos Creek above the Apex Water Utility is a Community Watershed under the Forest Practices Code of British Columbia Act. As such, forest fertilization, use of pesticides,

harvesting, range use and haul roads must be carried out in a way that achieves the water quality objectives established by the Ministry of Environment Lands and Parks for those watersheds. No logging has been proposed for the Community Watershed portion of Keremeos Creek, however logging is planned for 2000 and 2001 in other parts of the drainage.

Recreational activities in Kermeos Creek watershed may include hiking, mountain biking, motorcycle, ATV and four wheel drive useage. Although historic mining activity is recorded for the Keremeos Creek watershed, none presently occurs. Metals, including zinc, copper and lead, were not found in lower Keremeos Creek at concentrations greater than the provincial guidelines. Chromium is occassionally elevated and should be examined further, along with other metals, should mining activity resume in the watershed.

Maximum concentrations of ammonia, nitrite and nitrate were below guidelines for all water uses of Keremeos Creek. Phosphorus concentrations may be high enough to cause excessive algal growths if phosphorus is the limiting factor. Dissolved oxygen concentrations appear to be adequate to protect aquatic life, but further measurements are required to confirm this. Water temperature increases in lower Keremeos Creek due to the loss of streamside shade and may exceed the optimal temperature regime for salmonids.

South Keremeos Creek

In spite of the mineral development potential of the South Keremeos Creek drainage no mining has occurred. Chromium, copper, zinc and lead were at or below the BC approved and working water quality guideline to protect aquatic life. Further metals sampling would be required if mining were proposed for the drainage. Maximum concentrations of ammonia, nitrite and nitrate were all below guidelines. Cattle grazing occurs in the South Keremeos Creek drainage. Logging has occurred in this drainage in the past and is expected to resume in 2002. Turbidity and non-filterable residue concentrations in South Keremeos Creek are relatively low.

Cedar Creek

Cedar Creek is used for domestic drinking water without treatment. Cattle grazing occurs in the Cedar Creek drainage. Some logging activity has occurred in the past, and harvest plans have been set for 2002. Cedar Creek is relatively free of turbidity and with the exception of fecal coliform levels, all other parameters easily met the provincial guidelines to protect the most sensitive water use. Fecal bacteria counts would require that at least disinfection be applied to the water before consumption.

Olalla Creek

The Olalla water utility does not presently use Olalla Creek for domestic consumption, but private domestic licences are in effect on Olalla Creek. Logging and mining have occurred historically in the Olalla watershed and cattle grazing and logging presently occur in the watershed. The water of Olalla Creek is relatively free of turbidity and, with the exception of fecal coliform bacteria, all parameters met the provincial guidelines for the most sensitive water use. Fecal bacteria counts would require at least disinfection be applied to the water before consumption.

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WATER QUALITY OBJECTIVES

Water quality objectives proposed for upper and lower portions of Keremeos Creek, South Keremeos Creek, Cedar Creek and Olalla Creek are summarized in Table 1. The objectives are based on the BC approved and working guidelines for water quality, on known uses of the water resource, the limited available ambient water quality data, waste discharges, water uses and stream flows. The objectives are proposed to ensure that point and non-point source contamination are not preventing designated water uses from taking place. Objectives may be modified or added as found necessary due to knowledge of new water uses, new discharges which cause impacts on the creeks, receiving new data from water monitoring programs, or newly established water quality guidelines for other characteristics of concern.

The designated water uses for Keremeos Creek and Cedar Creek include: aquatic life, wildlife, irrigation, livestock watering and drinking water supplies. Water quality objectives are proposed for microbiological indicators, filterable and non-filterable residues, turbidity, ammonia, nitrite, nitrite/nitrate, pH, dissolved oxygen, dissolved chloride and chlorophyll-a (Table 1). An objective for water temperature is proposed for Keremeos Creek.

The designated water uses for South Keremeos Creek include: aquatic life, wildlife and livestock watering. Water quality objectives are proposed for microbiological indicators, turbidity, filterable and non-filterable residues, ammonia, nitrite, nitrite/nitrate, pH, dissolved oxygen and chlorophyll-a.

The designated water uses for Olalla Creek include: aquatic life, drinking water, wildlife, livestock watering and irrigation. Water quality objectives are proposed for microbiological indicators, turbidity, filterable and non-filterable residues, ammonia, nitrite, nitrite/nitrate, pH, dissolved oxygen, dissolved chloride and chlorophyll-a.

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WATER QUALITY MONITORING

Water quality objectives have been proposed for a number of water quality characteristics. Generally, these should be checked under worst-case flow conditions. For parameters such as fecal coliform bacteria, the worst-case conditions occur during the late winter or early spring when low elevation snow melt occurs and agricultural impacts are potentially high. Sampling in the watershed during freshet flows will be required to describe worst case conditions due to sediment loading and turbidity. Sampling for ammonia nitrogen, dissolved oxygen and temperature are important measurements in the summer when water flows are low and solar radiation high. To check attainment of average or percentile values, a minimum of five samples should be collected in a thirty-day period. For the purposes of checking attainment of the bacteriological objectives, use of the ninetieth percentile is recommended in situations where non-attainment occurs using five samples. Interpolation of the ninetieth percentile value from a graphical presentation of the 5 values can be carried out, however ten sampling dates is recommended. A proposed monitoring scheme is presented in Table 2; however, the water quality monitoring program undertaken may vary, depending on available resources.

Operational monitoring of forestry operations is important to ensure the Forest Practices Code requirements are met and water quality protected. Monitoring the effectiveness of the sediment control measures implemented at the Apex Mountain Resort is necessary to ensure adequate performance of the works installed. Sediment source surveys and riparian assessments, as recommended in the level one IWAP, may need to be conducted, should non-filterable residue and turbidity levels impair water use.

Periodic inspection of farming operations are conducted during low elevation snow melt to ensure the

Code of Agricultural Practice for Waste Management in BC is being followed. Protecting water quality is contingent on an adequate flow of water under normal conditions to sustain fish and aquatic life of the creeks. Minimum flow requirements to protect aquatic life need to be determined and a process of monitoring the adequacy of the flow targets established to provide adequate environmental protection of these water resources.

Lastly, perhaps the two most important initiatives necessary to protect water quality in the watershed are retaining and replanting streamside shade trees and stream stewardship. Without local initiatives to make people and communities feel connected to and responsible for the water course, protection of this resource is not complete.

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TABLES

The following tables provide a summary of the objectives data and monitoring recommendations. To protect water uses in a waterbody, objectives specify a range of values for characteristics (variables) that may affect these uses. These values are maximum, mean, and/or minimum values that are not to be exceeded.

Some readers may be unfamiliar with terms such as: maximum concentration, 30-day average concentration, or 90th percentile. Maximum concentration means that a value for a specific variable should not be exceeded; 30-day average concentration means that a value should not be exceeded during a period of 30 days, when five or more samples are collected at approximately equal time intervals. The term 90th percentile indicates that 9 out of 10 values should be less than a particular value.

To determine if objectives for non-filterable residue or turbidity have been exceeded, ideally, for short-term (acute) exposures, hourly samples taken over a 24-hour period are preferred to demonstrate the continuity of an event. Initially, less frequent monitoring may be appropriate to determine the need for more extensive monitoring. For long-term (chronic) exposures daily samples taken over a 30-day period are preferred, but also may initially be checked by less frequent monitoring. Obviously, the statistical reliability of the data is increased as the frequency of monitoring is increased.

TABLES

Table 1. Summary of Water Quality Objectives proposed for Keremeos Creek Watershed

Characteristics	Keremeos Creek	Olalla Creek Cedar Creek	South Keremeos Creek
Designated Water Uses	Aquatic life, wildlife, drinking water with partial treatment, livestock	Aquatic life, wildlife, livestock watering, irrigation and drinking water	Aquatic life, wildlife, livestock watering

	watering, irrigation	**with disinfection**	
fecal coliforms	**less than or equal to 10 CFU/100ml (90th percentile) at the Gunbarrel Intake and as a long-term objective in lower Keremeos Creek ..... less than 100 CFU/100ml (90th percentile) for areas downstream of Gunbarrel Intake as an interim objective in lower Keremeos Creek**	**less than or equal to 10 CFU/100ml (90th percentile)**	**less than or equal to 200 CFU/100ml (90th percentile**
non-filterable residue during clear flow	**less than or equal to 10 mg/L at Gunbarrel Intake site ... downstream of intake 25 mg/L increase in 24 hours or 5 mg/L in 30 days**	**25 mg/L increase in 24 hours or 5 mg/L in 30 days**	**25 mg/L increase in 24 hours or 5 mg/L in 30 days**
non-filterable residue during turbid flow	**10 mg/L increase if background is 25-100 mg/L or 10% maximum increase ... if background is greater than or equal to 100 mg/L then interim maximum is 150 mg/L at Triple Chair site**	**5 NTU increase when background is 5-50 NTU ... 10 % increase when background is greater than 50 NTU**	**5 NTU increase when background is 5-50 NTU ... 10 % increase when background is greater than 50 NTU**
	2.5 NTU average and 5 NTU maximum at Gunbarrel Intake		

turbidity during clear flow	... downstream of Gunbarrel Intake an 8 NTU increase over 24 hours or a 2 NTU increase over 30 days	1 NTU increase when background is less than 5 NTU	8 NTU increase over 24 hours or 2 NTU over 30 days
turbidity during turbid flow	5 NTU increase when background is 8-50 NTU 10% maximum increase when background exceeds 50 NTU	5 NTU increase when background is 8-50 NTU 10% maximum increase when background exceeds 50 NTU	5 NTU increase when background is 8-50 NTU 10% maximum increase when background exceeds 50 NTU
ammonia nitrogen	AMMONIA TABLE	AMMONIA TABLE	AMMONIA TABLE
nitrite nitrogen	NITRITE TABLE	NITRITE TABLE	NITRITE TABLE
nitrite + nitrate nitrogen	10 mg/L maximum	10 mg/L maximum	100 mg/L maximum ... less than or equal to 40 mg/L average
pH	6.5 to 8.5	6.5 to 8.5	6.5 to 9.0
dissolved oxygen	8.0 mg/L minimum 11.0 mg/L when salmonid embryos and larvae are present	8.0 mg/L minimum 11.0 mg/L when salmonid embryos and larvae are present	8.0 mg/L minimum 11.0 mg/L when salmonid embryos and larvae are present
chlorophyll-a	50 mg/m^2	50 mg/m^2	50 mg/m^2
filterable residue	500 mg/L in lower Keremeos Creek	500 mg/L	20% increase downstream
dissolved chloride	100 mg/L in lower Keremeos Creek	.....	.....
temperature	Keremeos Creek maximum of 17.0	.....	.....

	Celcius as a weekly average		

The objectives apply to discrete samples from all parts of Keremeos and South Keremeos Creek (specified in Table 1) except for initial dilution zones which are provisionally defined as extending up to 100 metres downstream from a discharge, and occupying no more than 50% of the stream width around a discharge point, from the bed of the stream to the surface. Initial dilution zones may be adjusted for Keremeos Creek using site specific information at the time of permiting a waste discharge.
1. The average fecal coliforms is calculated from at least 5 samples in a 30 day period. Ten samples are required for 90th percentiles.
2. The increase in mg/L of non-filterable residue or NTU of turbidity is over levels measured at a site upstream for a discharge or series of discharges and as close to them as possible and applies to downstream values.
3. The maximum chlorophyll-a is based on the average calculated from at least five randomly located samples from natural substrates at each site on any sampling date.
4. The weekly average temperature shall be calculated from 5 samples collected in the afternoon at downstream locations.

Table 2.1 Recommended Water Quality Monitoring for Keremeos Creek Watershed under Base Flow conditions

Site Number and Description	Frequency	Date	Variables
221390-Keremeos Creek at the base of the triple chair 221387-Keremeos Creek at XC bridge U/S of Apex STP 221386-Keremeos Creek U/S of Gunbarrel 221413-Keremeos Creek North Fork U/S of RV parking lot 221384-Keremeos Creek West Fork U/S of Apex parking lot	**5 times in 30 days at weekly intervals**	**July to April**	**N=30 True Color, pH, Non-Filterable Residue, Turbidity, Ammonia Nitrogen, Nitrite/Nitrate Nitrogen, Nitrite Nitrogen, Dissolved Chloride, Chlorophyll-a, MF fecal bacteria, Temperature, Dissolved Oxygen**
05007570-Keremeos Creek at Cawston E221340-Keremeos Creek at Olalla U/S of Olalla Creek E221339-Keremeos Creek	**5 times in**		**N=30 pH, Specific Conductance, Non-Filterable Residue, Filterable Residue, Turbidity,**

at Highway 3A E221341-Keremeos Creek at Keremeos E221391-South Keremeos Creek E221525-Cedar Creek U/S of Highway 3A E221526-Olalla Creek at Olalla	30 days at weekly intervals	July to April	Ammonia Nitrogen, Nitrite/Nitrate Nitrogen, Nitrite Nitrogen, Chlorophyll-a, MF fecal bacteria, Temperature, Dissolved Oxygen

Table 2.2 Recommended Water Quality Monitoring for Keremeos Creek Watershed under Freshet conditions

Site Number and Description	Frequency	Date	Variables
221389-Keremeos Creek at road to Dividend Mointain 221390-Keremeos Creek at the base of the triple chair 221387-Keremeos Creek at XC bridge U/S of Apex STP 221386-Keremeos Creek U/S of Gunbarrel 221413-Keremeos Creek North Fork U/S of RV parking lot 221384-Keremeos Creek West Fork U/S of Apex parking lot	5 times in 30 days at weekly intervals	May to July	N=30 Non-Filterable Residue, Turbidity
05007570-Keremeos Creek at Cawston E221340-Keremeos Creek at Olalla U/S of Olalla Creek E221339-Keremeos Creek at Highway 3A E221341-Keremeos Creek at Keremeos E221391-South Keremeos Creek E221525-Cedar Creek U/S of Highway 3A E221526-Olalla Creek at Olalla	5 times in 30 days at weekly intervals	May to July	N=30 Non-Filterable Residue, Turbidity

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